

CLAIMS

1. A method of handling a reflective mask suitable for patterning a projection beam of extreme ultraviolet electromagnetic radiation in a lithographic projection apparatus, comprising:

 handling the mask;

 holding the mask while handling the mask such that the mask is self-aligning, the holding comprising cooperation between a first set of connecting structures on the mask and a respective second set of connecting structures on the gripper such that a contact area between the mask and the gripper is minimized.

2. A method according to claim 1, wherein the first set of connecting structures comprises one of the group comprising a set of projections and a set of recesses, and the second set of connecting structures comprises the other one of the group.

3. A method according to claim 1, wherein said holding further comprises holding the mask by employing a non-contact force, selected from gravity, an electromagnetic force and combinations thereof.

4. A method according to claim 1, wherein said method further comprises transferring the mask from the gripper to a transfer gripper, the transferring comprising:

 moving said transfer gripper into position such that the first set of connecting structures contact a cooperating set of transfer connecting structures in the transfer gripper; and

 holding said mask with said transfer gripper by cooperation of said first set of connecting structures with said cooperating set of transfer connecting structure recesses.

5. A method according to claim 1, wherein said method further comprises holding said mask with two grippers, each gripper comprising a respective set of connecting structures which are constructed and arranged to cooperate with a respective set

of connecting structures provided in said mask, degrees of freedom of the set of connecting structures of each gripper being complementary to degrees of freedom of the set of connecting structures of the other gripper.

6. A reflective mask suitable for patterning a projection beam of extreme ultraviolet electromagnetic radiation in a lithographic projection apparatus, comprising a set of recesses disposed in a circumferential region of the mask, the recesses constructed and arranged to cooperate with a respective set of protrusions in a gripper of the lithographic projection apparatus so as to hold said mask in a self-aligning manner.

7. A reflective mask according to claim 5, wherein said set of recesses comprises grooves that are substantially oriented towards a common point.

8. A reflective mask according to claim 5, wherein said recesses are provided in respective brackets provided around said mask.

9. A reflective mask according to claim 5, wherein said mask is provided with at least two sets of recesses adapted for cooperation with respective sets of protrusions of separate grippers.

10. A reflective mask according to claim 8, wherein said mask is provided with sets of recesses at opposing sides of the mask.

11. A reflective mask according to claim 8, wherein said mask is provided with sets of recesses at one side of the mask.

12. A frame constructed to mount therein a reflective mask suitable for patterning a projection beam of extreme ultraviolet electromagnetic radiation in a lithographic projection apparatus, wherein said frame comprises a set of recesses for cooperation with a respective set of protrusions in a gripper of the lithographic projection apparatus so as to hold said frame in a self-aligning manner while handling.

13. A device for handling a reflective mask suitable for patterning a projection beam of extreme ultraviolet electromagnetic radiation in a lithographic projection apparatus, said device including a gripper comprising a set of protrusions constructed and arranged to cooperate with a respective set of recesses provided in a circumferential region of said mask so as to hold said mask in a self-aligning manner while handling.

14. A device according to claim 13, wherein said gripper is constructed and arranged to hold the mask by a non-contact force, selected from the group comprising gravity, electromagnetic force and combinations thereof, against said set of protrusions at one side of the mask.

15. A device according to claim 13 wherein the device comprises two grippers each having a set of protrusions for cooperation with respective sets of recesses in said mask, degrees of freedom of a set of protrusions of one gripper being complementary to degrees of freedom of a set of protrusions of the other gripper.

16. A device according to claim 15, wherein the device comprises a mask table for holding the mask by an electrostatic force, the mask table comprising one of said grippers, which has a degree of freedom in a direction perpendicular to a mask-bearing surface of said mask table.

17. A device according to claim 13, the device forming a portion of a lithographic projection apparatus comprising:

 a radiation system to provide the projection beam of extreme ultraviolet electromagnetic radiation;

 a mask table to hold the reflective mask, the mask serving to pattern the projection beam according to a desired pattern upon reflection of the projection beam at the mask so as to yield a patterned projection beam;

 a substrate table for holding a substrate; and

a projection system for projecting the patterned projection beam onto a target portion of the substrate.

18. A device according to claim 13, the device being one of a mask manufacturing apparatus, a mask cleaning apparatus and a mask inspection apparatus.

19. A device according to claim 13, the device being a mask storage box.

20. A device manufacturing method comprising:
projecting a patterned beam of radiation onto a target portion of a layer of radiation-sensitive material,

handling a reflective mask which provides a pattern to the patterned beam by self-aligning holding said mask, the self-aligning holding comprising cooperation between a first set of connecting structures on the mask and a respective second set of connecting structures on the gripper such that a contact area between the mask and the gripper is minimized.

21. A semiconductor device manufactured according to the method of claim 20.

22. A method of handling a reflective mask suitable for patterning a projection beam of extreme ultraviolet electromagnetic radiation in a lithographic projection apparatus comprising:

kinematically-determined holding said mask while handling, said kinematically-determined holding comprising cooperation of a set of structures on a gripper with a respective set of structures provided in a circumferential region of the mask, said structures selected from the group comprising protrusions and recesses.

23. A method of positioning a mask with respect to a mask gripper, the mask having an imaging portion and locating surfaces fixed with respect to the imaging

portion, the gripper having cooperating locating surfaces that can engage the mask locating surfaces comprising:

engaging the gripper locating surfaces with the mask locating surfaces so as to position the imaging portion with respect to the gripper;

maintaining the engagement between the gripper locating surfaces with a non-contact force applied to the mask.

24. A method as in claim 23 wherein the force is an electromagnetic force.

25. A method as in claim 23 wherein the force is gravitational.